

HPCBS

High Performance Commercial Building Systems

Data Logging Guide for Andover Controls Energy Management and Control Systems

Element 5 - Integrated Commissioning and Diagnostics

Project 2.2 - Monitoring and Commissioning of Existing Buildings

Task 2.3.1 - Develop a guide to implementation of monitoring systems in existing buildings

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Data Logging Guide

for

Andover Controls

**Energy Management and
Control Systems**

Submitted by

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Table of Contents

EXECUTIVE SUMMARY	5
CHAPTER 1. INTRODUCTION	6
CHAPTER 2. DETERMINE EXISTING SYSTEM FUNCTIONALITY	8
CHAPTER 3. APPLICATION SET-UP PROCEDURES	19
APPLICATION A. ELECTRICAL CONSUMPTION AND DEMAND MONITORING USING A WATT HOUR TRANSDUCER	20
APPLICATION B. ELECTRICAL CONSUMPTION MONITORING USING A WATT TRANSDUCER	35
APPLICATION C. THERMAL CONSUMPTION MONITORING USING A BTU METER	46
APPLICATION D. THERMAL CONSUMPTION MONITORING USING AN EMCS	61
APPLICATION E. ROOM TEMPERATURE MONITORING.	72
APPLICATION F. DATA COLLECTION CONFIGURATION AND STORAGE IN CONTINUUM CYBERSTATION WORKSTATION SOFTWARE	81
APPENDICES	83
APPENDIX A: ELECTRICAL CONSUMPTION ACCUMULATION PROGRAM	84
APPENDIX B: THERMAL CONSUMPTION ACCURACY	87
APPENDIX C: THERMAL CONSUMPTION CALCULATION PROGRAM	89
APPENDIX D: EXTENDED LOG ARCHIVING PROGRAM	91

EXECUTIVE SUMMARY

This Guide presents detailed procedures to determine the monitoring capability of an existing EMCS (Energy Management Control System) and perform any upgrades to the EMCS to enable data logging. This Guide outlines procedures to enable an existing EMCS to measure the hourly energy consumption of a building or facility. The parameters to monitor include electrical consumption, thermal consumption (flow and temperatures), room temperature and other physical parameters.

This Guide enables the user to understand and verify how the existing controller can be configured to monitor the above parameters. Briefly, this includes:

- Determining the functionality of the existing EMCS controller models and software versions.
- Upgrading the physical monitoring capability of the existing controller, if needed.
- Selecting the correct sensors for the application in existing EMCS controllers.
- Following procedures to set-up and configure the EMCS to log the desired data.

Once these procedures are fully implemented, the existing EMCS can be effectively used as a data logger. This results in a very cost effective method to acquire data logger quality data in an existing EMCS.

CHAPTER 1. INTRODUCTION

This Guide covers products designed by Andover Controls and introduced since 1994. A complete list of Andover Controls software and hardware products that have been installed since 1994 are detailed in this Guide. Improvements to the products are also covered. This Guide presents detailed procedures to determine the monitoring capability of an existing Andover Controls EMCS (Energy Management Control System) and perform any needed upgrades to the EMCS to enable data logging.

Chapter 2 covers how to determine the functionality of the existing EMCS controller and software versions. Also covered is how to determine if upgrades are needed to the existing system. After implementing the steps in Chapter 2, the base system will be ready to be configured and used as a data logger.

Chapter 3 then covers specifically how to set-up and configure the EMCS as a data logger. Procedures are provided to enable selected data logger monitoring functions. These include electrical consumption, thermal flow and room monitoring. Data collection and storage requirements are also provided.

The Appendices covers programming details and accuracy determinations. A specific electrical consumption accumulation program, a thermal consumption calculation program and an extended log archiving program are provided. An example of temperature accuracy is provided so that the user can better determine the accuracy of thermal measurements.

This Guide enables the user to understand and verify that the existing controller can be configured to monitor the above parameters. Briefly, this includes:

- Determining the existing EMCS controller models and software versions.
 - Table 1 in Chapter 2 lists Andover Controls' controllers and software versions. If the existing controller models and software versions found in the facility are listed in

Table 1, this Guide can be used to upgrade the EMCS to store historical data of the parameters needed to determine the hourly energy consumption in a facility.

- Upgrading the physical monitoring capability of the existing controller, if needed.
 - Chapter 2 contains guidance on what will need to be upgraded based on the existing EMCS models and software.
- Selecting the correct sensors for the application in existing EMCS controllers.
 - Chapter 3 provides information about what input types different controllers can accept and provides accuracy of the sensors. Guidance in selecting the correct sensor type is provided.
- Following procedures to set-up and configure the EMCS to log the desired data.
 - Chapter 3 provides procedures to configure the EMCS to log data for specific applications. The applications include electrical consumption and demand monitoring using a Watt-Hour transducer, electrical consumption and demand monitoring using a Watt transducer, thermal monitoring using a BTU meter or EMCS, monitoring room temperature and data collection and storage guidance.

CHAPTER 2. DETERMINE EXISTING SYSTEM FUNCTIONALITY

- Step 1: Check the software version and the existing controller model of the controller connected to the sensor that will be used.
- Step 2: Verify the firmware release and hardware/software compatibility.
- Step 3: Find the general specification of the controller and the input type for each controller.
- Step 4: Check data logging performance of controller.
- Step 5: Upgrade EMCS for data logging

Details of each step follow.

Step 1: Check the software version and the existing controller model of the controller connected to the sensor that will be used

If the controller model is listed in Table 1, this Guide can provide a guideline to set-up and store the history data. If the existing controller model is not included, consult with Andover Controls for the possibility of using the existing controller or upgrading it to a current model.

Table 1. Andover Controls Hardware and Software Products

Hardware	
Controller Family	Model Number
Continuum System	Continuum NetController CPU Module I/O Modules <ul style="list-style-type: none"> • UI-8-10 • DI-8 • MI-6
Infinity System Controller	SCX 920 LCX 800, LCX 800 I LCX 810
An Eclipse Controller	Eclipse CX 9400 Central Processing Unit Eclipse I/O Modules <ul style="list-style-type: none"> • UI-32-12, UI-16-12, UI-32-16 or UI-16-16 • DI-32-DRY
Software	
Continuum™ CyberStation™ Workstation Software SX 8000 Front End Software	

There are three families of controllers for use as monitor and control instruments: the Continuum System, the Infinity System and the Eclipse Controller system. These controllers are categorized into two types of controllers, Network controllers and Infinet controllers. While Network controllers are controllers that reside on and communicate through an Ethernet network (primary network), Infinet controllers are special function stand-alone controllers that communicate with Network controllers through a proprietary network called the Infinet (secondary network).

NetController and Eclipse CX 9400 are examples of Network controllers with the input/output modules. These controllers consist of a CPU module and memory and communication ports including interface to distributed Infinity Infinet Controllers. They provide network management and full system control of a building. Another example of a Network controller is CMX 240. It is a system coordinator for Infinet controllers with direct-connect or dial-up communication ability. CMX 240 does not have input/output module reading. Therefore, it cannot be used directly for monitoring but can be the coordinator for Infinet controllers. The examples of special function Infinet controllers are SCX and LCX series controllers.

- Continuum NetController CPU: This controller acts as the system coordinator for the Continuum I/O modules. It provides integrated global control and monitoring, history logging, and local and remote alarming. The following I/O modules are used with this controller:
 - UI-8-10: Provides 8 universal inputs which are software configurable as either voltage, thermistor, digital or counter point types.
 - DI-8: Provides 8 digital inputs which are software configurable to accept a digital or counter signal.
 - MI-6: Perfect match for temperature transmitters, humidity and pressure transducers, and gas monitors with either a 0-24mA or 4-20mA output.
- SCX 920: This controller is a standalone, programmable microprocessor-based system controller that is used for direct digital control (DDC) of chillers, cooling towers, boilers, air handling units, perimeter radiation, lighting, etc. The controller has 16 universal inputs, 8 universal outputs, and contains an I/O expansion port.
- LCX 800: The LCX 800 is a standalone, programmable microprocessor-based controller used for DDC and monitoring of packaged HVAC units, heat pumps and fan coil units. This controller provides 8 universal inputs and 8 Form C relay outputs.
- LCX 800I: This controller is a scaled down version of the LCX 800. It has 8 universal inputs and no relay outputs.

- LCX 810: This is a standalone, programmable microprocessor-based controller used for DDC and monitoring of packaged HVAC units, heat pumps and coil units. It has 8 universal inputs, 8 Form C relay outputs and contains an I/O expansion port.
- Eclipse CX9400 Central Processing Unit: The CX9400 is the CPU board for the Eclipse family of controllers and the system coordinator for all distributed Infinity Infinit controllers. This system is available with either 4 or 8 I/O slots. The following I/O modules are available with this system:
 - UI-32-12: Provides 32 universal inputs, which are software configurable, as either thermistor, digital, voltage or counter point types.
 - UI-16-12: Provides 16 universal inputs and the same point type selection as the UI-32-12.
 - UI-32-16: Provides 32 universal inputs, which are software configurable, as either voltage, current, thermistor, 1000 ohm RTD, digital and counter point types.
 - UI-16-16: Provides 16 universal inputs and the same point type selection as the UI-32-16.

Andover Controls has two versions of software, Continuum CyberStation Workstation Software and SX 8000 Front End Software. Continuum CyberStation Workstation Software is a Microsoft Windows NT-based graphical user interface. This software provides the means to control and monitor HVAC, lighting, access and process systems. Continuum stores all facility data in a single Microsoft ODBC-compliant SQL database. SX 8000 Front End Software is designed for single-user and multi-user applications in direct connect and remote communications. SX 8000 Front End supports leading network operating systems such as Microsoft Windows NT Server and Microsoft OS/2 LAN Manager and features the Microsoft SQL database server software. High-resolution graphics assist with control of a building's HVAC, lighting, and access control and process systems. For more information, please contact Andover Controls representatives.

Step 2: Verify the firmware release and hardware/software compatibility

As a general rule for Infinity and Continuum systems, the revision of the workstation software must match the revision of the network-level controllers at least to the first place after the decimal. For example, on an Infinity system, if the SX 8000 front-end is at revision 2.175 and the CX 9200 controller is at revision 2.17, then they are compatible. On the Infinet field bus, the rules are more relaxed such that multiple revisions of the same controller can co-exist on the same Infinet.

SX 8000 Front-End and Continuum CyberStation are only two types of software offered from Andover since 1994. Table 2 lists the software revision numbers and date released for these two types of software and the compatible controllers for each. In general, upgrading the revisions to the current revision throughout a system is recommended as each new revision includes enhancements and problem fixes. For more information, please contact Andover Controls representatives.

Table 2. Andover Controls Product Revision History

Software: SX 8000 Front-End		Software: Continuum CyberStation	
Compatible Controllers: Eclipse (CX 9400) CX 9200 CMX 240 CMX 220		Compatible Controllers: NetController (CX 9900) Eclipse (CX 9400) CX 9200 CMX 9924	
Revision Number	Revision Date:	Revision Number	Revision Date
Rev 1.6	Jan 1994	Rev 1.0	Dec 1998
Rev 1.7	Oct 1994	Rev 1.1	June 1999
Rev 2.0	July 1995	Rev 1.2	Aug 1999
Rev 2.1	Dec 1995	Rev 1.3	Dec 2000
		Rev 1.4	Sept 2001

Step 3: Use Table 3 to find the general specification of the controller and the input type for each controller

The four input types included for analog inputs are current, voltage, thermistor and platinum RTD. The digital input type requires the input to have a counter or accumulator feature. For example, if SCX 920 is used to monitor room temperature, we can conclude from Table 3 that a voltage, current or thermistor type temperature sensor can be used with this controller. This will help select the correct sensor.

Table 3. Andover Controls Hardware Specification

Model	Analog Input				Digital Input	
	Current	Voltage	Thermistor	Platinum RTD	Digital	Counter
Continuum I/O Module UI-8-10	N/A	0-5 V DC Accuracy: ± 15 mV	10 KΩ, type III Accuracy: ± 1°F Over 40-100°F range	N/A	N/A	
Continuum I/O Module DI-8	N/A	N/A	N/A	N/A	Contact Closure High Speed Counting (channel 1,2 in Hi Speed Mode) Freq.: 10 kHz Pulse Width: 50 μs Low Speed Counting (channel 3-8 and 1,2 in Lo Speed Mode) Freq.: 10 Hz Pulse Width: 50 ms	
Continuum I/O module MI-6	0-20 mA Accuracy: ± 80μA	N/A	N/A	N/A	N/A	
SCX 920	0-20 mA Accuracy: ± 30μA	0-10 V DC Accuracy: ± 5 mV	10 KΩ Accuracy: ± 0.46°F Over -10 to 150°F	N/A	Contact Closure Freq.: 5 Hz (max) Pulse Width: 100 ms (min)	

Table 3. Andover Controls Hardware Specification (continued)

Model	Analog Input				Digital Input	
	Current	Voltage	Thermistor	Platinum RTD	Digital	Counter
LCX 800/800I	0-20 mA Accuracy: $\pm 80\mu\text{A}$	0-5 V Accuracy: $\pm 15\text{ mV}$	10 K Ω Accuracy: $\pm 1.5^\circ\text{F}$ Span: -10 to 150°F	N/A	Contact Closure Freq.: 4 Hz (max) Pulse Width: 125 ms (min)	
LCX 810	0-20 mA Accuracy: $\pm 30\mu\text{A}$	0-10 V Accuracy: $\pm 2.5\text{ mV}$	10 M Ω Accuracy: $\pm 0.46^\circ\text{F}$ Span: -10 to 150°F	N/A	Contact Closure Freq.: 4 Hz (max) Pulse Width: 125 ms (min)	
Eclipse I/O module UI-16-12, UI-16- 16, UI-32-12 or UI- 32-16	0-20 mA Accuracy: $\pm 30\mu\text{A}$ Only on UI-16-16 and UI-32-16	0-10 V Accuracy: $\pm 5\text{ mV}$	10 M Ω Accuracy: $\pm 0.26^\circ\text{F}$ Span: -10 to 100°F	1000 Ω RTD Accuracy: $\pm 0.45^\circ\text{F}$ over -328 to 122°F Only on UI-16-16 and UI-32-16	Contact Closure Freq.: 5 Hz (max) Pulse Width: 100 ms (min)	
Eclipse I/O module DI-32-DRY	N/A	N/A	N/A	N/A	Contact Closure Freq.: 5 Hz (max) Pulse Width: 100 ms (min)	

Step 4: Check data logging performance of controller

Once the existing controller is identified, use Table 4 to check for acceptable data logging performance of the controller for each monitoring parameter: electrical consumption, thermal consumption and room temperature. Table 4 provides recommendations in the event the existing controller cannot be used to monitor a parameter.

Table 4. Andover Controls Hardware and Monitoring Capabilities Compatibility

Sensor Device Output	Electrical Consumption		Thermal Consumption		Room Temperature
	Digital	Analog	Digital	Analog	Analog
Continuum NetController with I/O module	•	•	•	•	•
SCX 920	•	•	•	•	•
LCX 800/800I	•	•	•	•	•
LCX 810	•	•	•	•	•
Eclipse 9400 with I/O module	•	•	•	•	•

- Indicates acceptable performance for logging a point type

Step 5: Upgrade EMCS for data logging

The suitability of the existing EMCS equipment should now be determined so that any needed upgrades can be accomplished. For example, if a remote panel needs to be upgraded to improve the accuracy, this should be done before continuing with the set-up procedures in Chapter 3.

After establishing the compatibility and type of parameter to be monitored and logged and after knowing which type of meter or calculation to be used, the set-up procedures can be selected.

The following application set-up procedures are outlined in Chapter 3 for specific functions:

- Electrical Consumption and Demand Monitoring Using Watt Hour Transducer (digital input)
- Electrical Consumption and Demand Monitoring Using Watt Transducer (analog input)
- Thermal Consumption Monitoring Using BTU Meter
- Thermal Consumption Monitoring Using EMCS
- Room Temperature Monitoring

CHAPTER 3. APPLICATION SET-UP PROCEDURES

The following procedures and charts provide the requirements to enable existing controllers to perform specified functions. These procedures are covered in detail in Chapter 3.

Application A. Electrical Consumption and Demand Monitoring Using a Watt-Hour Transducer.

Application B. Electrical Consumption Monitoring Using a Watt Transducer.

Application C. Thermal Consumption Monitoring Using a BTU Meter.

Application D. Thermal Consumption Monitoring Using an EMCS.

Application E. Room Temperature Monitoring.

Application F. Configure For Data Collection and Storage in Continuum CyberStation
Workstation Software.

Application A. Electrical Consumption and Demand Monitoring Using a Watt Hour Transducer

Application A provides the user with steps to follow in setting up a Watt Hour Transducer to monitor electrical consumption and demand. By following these steps, the user will enable the EMCS to measure electrical consumption (kWh) and store fifteen-minute data. Chart A-1 lists the needed equipment and helps determine if the controller has an available input slot. Chart A-2 aides the user in choosing a Watt Hour Transducer (WHT) and a Current Transducer (CT). For the different controller models, the chart lists the accuracy, pulse widths and pulse rates the WHT and CT must contain, and wire and sensor specifications. Some tips for CT installation are provided as well. Chart A-3 provides an example of a WHT and a CT available in the market. Chart A-4 provides the EMCS programming steps. By following these steps, the user will enable the EMCS to accumulate monthly consumption and record 15-minute consumption. The user should then proceed to Application F to set-up the data collection and history data storage.

Step 1. Check the input slot availability on the controller.

Use Chart A-1 to find which slots are needed on the controller. The position of the slot can be found in Chart A-1 under Controller Terminal Connections. For example, the Continuum NetController with UI-8-10 needs an available slot on the IN 1-8 terminal blocks. If slots are available on any of these, the procedure can be followed. If there are no available slots, contact an Andover Controls representative to check whether an expansion I/O module can be added to this controller or if an additional controller needs to be installed.

Step 2. Choose a Watt Hour Transducer (WHT) and Current Transducer (CT).

Chart A-2 lists the WHT and CT specifications. For example, an acceptable Watt Hour Transducer for NetController with UI-8-10 should have discrete output with $\pm 0.5\%$ accuracy or better and a 125 ms minimum pulse width at a 4 Hz maximum pulse rate.

With matching CT output and accuracy selection of $\pm 1\%$ or better, the end-to-end accuracy from the transducers to the NetController with UI-8-10 could be around $\pm 1.5\%$.

Chart A-3 shows an example of a WHT and a CT provided in the market.

Step 3. Follow the EMCS programming steps.

Chart A-4 provides the steps to set-up the external input point from the transducer and the internal points to store the consumption value the EMCS will need to recognize. Detailed steps provided in this chart must be followed to set-up the external input point and internal points.

Step 4. Follow the steps in Application F.

Application F lists the steps to set-up the data collection and history data storage.

After the steps are complete, the system will then be usable to collect monthly consumption and record 15-minute demand.

Chart A-1. Electrical Consumption And Demand Monitoring Using A Watt-Hour Transducer

Verify that the controller has the available slots as discussed below. Also, the terminal connections on the controller need to have the resistors connected as specified below.

	Continuum NetController with UI-8-10	Continuum NetController with DI-8	SCX 920	LCX 800/800I	LCX 810	Eclipse 9400 with UI-xx-yy* or DI-32-DRY
What is measured	<ul style="list-style-type: none"> Electrical consumption of either One-Phase or Three Phase, 208 to 480 VACrms, 50/60 Hz 					
What is stored in EMCS	<ul style="list-style-type: none"> Fifteen-minute data of electrical consumption in kWh units stored in Trend Data History. 					
What is needed	3 - CT sensor 1 - Watt Hour Transducer 1 – available slot on Terminal Block (for external discrete input) 1 – available internal pulse input point (to accumulate month-to-date consumption)					
Controller Terminal Connections	IN 1-8	High Speed Counter: IN 1-2 Low Speed Counter: IN 1-8	IN 1-16	IN 1-8	IN 1-8	IN 1-16 for 16 inputs and IN 1-32 for 32 inputs
DIP Switch Position	Ref. Resistor: ON Voltage Range: 5V (Optional)	For IN 1-2 High Speed Counting, High Speed Counter: ON	Ref. Resistor: IN	N/A	Ref. Resistor: IN	Current Sense Resistor: OFF Or Pull-up Resistor: ON

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

Chart A-2. Electrical Consumption And Demand Monitoring Using A Watt-Hour Transducer

Watt Hour Transducer and Current Transducer Specifications

	Continuum NetController with UI-8-10	Continuum NetController with DI-8	SCX 920	LCX 800/800I	LCX 810	Eclipse 9400 with UI-xx-yy* or DI-32-DRY
Output Type from Watt Hour Transducer	Discrete (each pulse is equal to xxx kWh, varies with specific sensor)					
Maximum Pulse Rate	4 Hz	High Speed Counting: 10 kHz and Low Speed Counting: 10 Hz	5 Hz	4 Hz	4 Hz	5 Hz
Minimum Pulse Width	125 ms	High Speed Counting: 50 μ s and Low Speed Counting: 50 ms	100 ms	125 ms	125 ms	100 ms
Accuracy from Watt Hour Transducer	± 0.5 % (not including CT's)					
CT Accuracy	± 1.0 %					
Note	CT sensors Output: Match the input type for Watt Hour Transducer Input: Make sure that input current is enough to cover the normal current					
End-to-end Accuracy	± 1.5 %					

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

Next, the specifications for the Watt Hour Transducer must satisfy the input requirements for the controller.

Make sure that the device will cover the peak demand kW, will not generate more pulses than the maximum pulse rate and will maintain the signal pulse width at least for the minimum pulse width duration.

Current transformers have several styles. Split core CTs are easier to install. To ensure these are installed in the correct direction, check the polarity of the current read by the EMCS.

Notes on installation:

- Install CT sensors on the electrical main panel. Follow the manufacturer's instructions.
- Install Watt Hour Transducer and terminate CT sensor outputs at the WHT inputs. Follow the manufacturer's instructions.
- Electrical shock can occur from CT's without a shunt resistor.
- Terminate Watt Hour Transducer output at the Terminal Block. Follow the manufacturer's instructions.

Chart A-3. Electrical Consumption And Demand Monitoring Using A Watt-Hour Transducer

An Example of Watt Hour Transducer Specifications

The following Watt-Hour Transducer has been successfully used.

Watt Hour Transducer		
Ohio Semitronics, Inc.		
WL-3968		
Input	Current	Output from Current Transformer 0 - 0.333 V
	Voltage	120/208 & 277/480
	Phase	Three-Phase, Three-Wire or Three-Phase, Four-Wire
	Range	± 15%
	Burden	None
	Power Factor	0.5 Lead to 0.5 Lag
	Instrument Power	208/240/480, 50/60 Hz, 2.5 Watts
Output	Relay	Dry Contact, 120 V, 0.3 A, 10 VA Max
	Closure Duration	250 Milliseconds
	Accuracy	± 0.5% F.S.
	Isolation	Input/Output/Case 750 VAC
	Temperature Effects	(-20°C to +60°C) ± 0.02%/°C

Chart A-3. Electrical Consumption And Demand Monitoring Using A Watt-Hour Transducer (continued)

An Example of Current Transducer Specifications

The following Current Transducer has been successfully used.

Current Transducer		
Sentran Corporation		
4LS3 Split Bus Bar		
Input	Current	AC current, sinewave, single phase 60 Hz, Load PF 0.5-1 lead or lag 100, 200, 300, 400, 500, 600, 800, 1K, 1.5K, 2K, 2.5K and 3K Amp
	Voltage rating	600 VAC Tested Per ANSI C57.13 BIL 10 KV AC Full Wave for 60 seconds
	Bandwidth	10 Hz to 1000 Hz \pm 3 db
Output	Voltage	100 mV, 250 mV, 333 mV, 500 mV, 1 V and 5 V
	Limiting	20 V AC RMS
	Accuracy	\pm 1% ratio and linearity accuracy from 5% to 200% of scale
	Phase Displacement	\pm 1 degree
	Output Resistance	< 100 Ohms
	Interface Resistance	> 10K Ohms
	Lead Wires	20 or 22 AWG UL1015, 600V insulation, 105 C

Chart A-4. Electrical Consumption And Demand Monitoring Using A Watt-Hour Transducer

EMCS Programming Steps

Summary

The following Steps are covered in detail in Chart A-4

- Step 1. Set-up external pulse input point in EMCS to accumulate daily consumption for the Wh-to-pulse transducer.
- Step 2. Set-up internal output point to accumulate monthly consumption from external point created in Step 1.
- Step 3. Create a trend point extension on the internal output point in the EMCS to record the 15-minute accumulated consumption values.
- Step 4. Add a programming step to accumulate the counter value created in Step 1 and store in the point created in Step 2.

Details of these steps follow.

Step 1. Set-up an external pulse input (PI) point in EMCS to accumulate daily consumption for Wh-to-pulse transducer.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

- a. Connect installed sensors to the controller.
- b. From “Menu” page, click “Tool”, then “Continuum Explorer”.
- c. Right click on the controller to which the point will be added.
- d. Select “New” from the menu, and then select “InfinityInput”.
- e. New dialog box will be displayed. Enter the name and alias and click “Create”.
- f. InfinityInput Editor will be displayed. Set the following parameters as specified below:
 - In “General” Tab,

Value	0 (This value will be shown when this point is not active)
Unit	kWh
Description	Enter a point description up to 32 characters in length
State	Enabled

Continued on Next Page

- In “Setting” Tab,

	Continuum NetController with UI-8-10	Continuum NetController with DI-8	SCX 920	LCX 800/800I	LCX 810	Eclipse 9400 with UI-xx-yy* or DI-32-DRY
ElecType	Counter					
Channel	x, x is the terminal connection IN-x. For example, a sensor is installed at IN-5, the channel is 5.					
IOU	Number of the Input/Output module that is sending the input	0	0	0	0	Number of the Input/Output board on Lbus
Format	###.## (floating point)					
Digital Filter	False					

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

- In “Conversions” Tab

Threshold	0.00 (The point will be updated with every change)
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Step 2. Set-up internal output point to accumulate monthly consumption from external point created in Step 1.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

- a. In Continuum Explorer window, right click on the controller to which the point will be added.
- b. Select “New” from the menu, and then select “InfinityNumeric”.
- c. New dialog box will be displayed. Enter the name and alias and click “Create”.
- d. InfinityNumeric Editor will be displayed. Set the following parameters as specified below:
 - In “General” Tab,

Value	0 (This is the initial value)
Unit	kWh
Description	Enter a point description up to 32 characters in length
Channel and IOU number	(NetControllers only) Enter the channel number as it is marked on the controller. Enter an IOU number.
Direction	IOOutput
State	Enabled
Setpoint	No Check
Format	###.## (2 decimal floating points)

Step 3. Create a trend point extension on the internal output point in the EMCS to record the 15-minute accumulated consumption values.

Continue from Step 2. “InfinityNumeric Editor” window will be displayed. Set the following parameters as specified below:

- In “Logs” Tab, on the left side of the Logs page

Number of Entries	3,500 (3,500 points will be kept at the controller)
Type	LogInstantaneous
Interval	Days: 0 Hours: 0 Minutes: 15 Seconds: 0 (Andover automatic logs always start at the top of the hour, so the data will be recorded every quarter of the hour)

- In “Logs” Tab, on the right side of the Logs page

Number of Entries	17,520 (the maximum amount of numbers that Continuum database will keep)
Interval	Days: 0 Hours: 4 Minutes: 0 Seconds: 0 (Continuum will store new values in the log every four hours)
	Note: To maintain a good data history, a monthly export of data is needed.

Step 4. Add a programming step to accumulate the counter value created in Step 1 and store in the point created in Step 2.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

- a. In Plain English Integrated Development Environment, click “New” from the IDE File menu. The Create dialog box will display a list of objects.
- b. In Network View, under Device section, select the controller in which this program will be stored.
- c. Enter the name of this program, up to 16 characters, in the field marked “Object Name”.
- d. Click “Create”, then configure program file attributes.
- e. Select “Configuration” from the File menu and fill in the configuration page dialog box.
- f. Click “Enabled” state, “Looping” flow type, and check the boxes on “Autostart” and “Command Line”.
- g. Select run time page and then click “OK”.
- h. New program editor window will be displayed. Enter the program lines to accumulate the electrical consumption (See Appendix A).
- i. When complete and before saving a file, make sure the Assistant window is displayed.
- j. From File Menu select “Save”. The IDE automatically checks the file for errors before saving. If errors are found, the Check tab on the Assistant window becomes active and lists the errors. The IDE will not save a program file and will not close until all the errors are fixed.

Application B. Electrical Consumption Monitoring Using A Watt Transducer

Charts B-1 through B-4 provide the user with steps to follow in setting up a Watt Transducer to monitor electrical consumption and demand. By following these steps, the user will enable the EMCS to measure electrical consumption (kWh) and store fifteen-minute data. Chart B-1 lists the needed equipment and will help the user determine if the controller has an available input slot. Chart B-2 aids the user in choosing a Watt Transducer (WT) and a Current Transducer (CT). The table lists accuracy, output type, maximum lengths of wire for the WT and CT, and wire and sensor specifications for different controller models. Chart B-3 provides an example of a WT and a CT available in the market. Chart B-4 provides the EMCS programming steps. By following these steps, the user will enable the EMCS to accumulate monthly consumption, display current demand and record 15-minute consumption. The user should then proceed to Application F to set-up the data collection and history data storage.

Step 1. Check the input slot availability on the controller.

Use Chart B-1 to find which slots are needed on the controller. The position of the slot can be found in Chart B-1 under Controller Terminal Connections. For example, Continuum NetController with MI-6 needs an available slot on IN 1-6. If slots are available on either of these the procedure can be followed. If there are no available slots, contact an Andover Controls representative to check whether an expansion I/O module can be added to this controller or if an additional controller needs to be installed.

Step 2. Choose a Watt Transducer (WT) and Current Transducer (CT).

Chart B-2 lists the WT and CT specifications. For example, an acceptable Watt Transducer for NetController with MI-6 should have analog output (preferred current 4-20 mA) with 0.5% accuracy or better. With matching CT output and accuracy selection of 1% or better, the end-to-end accuracy from the transducers to the NetController with MI-6 could be around 1.5%. Note that to gain this accuracy the transducers must be placed no further than 500 ft. away with 18 AWG wire type

Chart B-3 shows an example of a WT that is provided in the market. CT is included in this Watt Transducer example.

Step 3. Follow the EMCS programming steps.

Chart B-4 provides the steps to set-up the external input point from the transducer and the internal points to store the consumption value the EMCS will need to recognize. Detailed steps provided in this chart must be followed to set-up the external input point and internal points.

Step 4. Follow the steps in Application F.

Application F lists the steps to set-up the data collection and history data storage.

After these steps are complete, the system will then be usable to record monthly consumption and display current demand.

Chart B-1. Electrical Consumption Monitoring Using Watt Transducer

Verify that in addition to the sensors and transducer, that the controller has the available slots as discussed below. Also, the terminal connections on the controller need to have the resistors connected as specified below.

	Continuum NetController with UI-8-10	Continuum NetController with MI-6	SCX 920	LCX 800/800I	LCX 810	Eclipse 9400 with UI-xx-yy*
What is measured	Electrical consumption of either One-Phase or Three Phase, 208 to 480 VAC rms, 50/60 Hz					
What is stored in EMCS	Fifteen-minute data of Electrical Consumption in kWh units stored in Trend Data History.					
What is needed	3 - CT sensor 1 - Watt Transducer 1 – available slot on Terminal Block (for analog input) 1 – available internal accumulative points for electric consumption					
Controller Terminal Connections**	IN 1-8 (voltage)	IN 1-6 (current)	IN 1-16	IN 1-8	IN 1-8	IN 1-16 for 16 inputs and IN 1-32 for 32 inputs
DIP Switch Position	Ref. Resistor: OFF Voltage Range: 5V for 0-5V Input Range or 10V for 0-10V Input Range (Optional)	N/A	Ref. Resistor: OUT For Current Input: recommended additional resistor across the input, 475 Ω , 0.1% for a 0-20 mA input	For Current Input: recommended additional resistor across the input, 249 Ω , 0.1% for a 0-20 mA input.	Ref. Resistor: OUT For Current Input: recommended additional resistor across the input, 475 Ω , 0.1% for a 0-20 mA input.	Pull-up Resistor: OFF Current Sense Resistor: OFF for voltage input, ON for current input (Optional)

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

** Controller Terminal Connections for analog inputs, both current and voltage inputs, otherwise stated.

Chart B-2. Electrical Consumption Monitoring Using Watt Transducer

Watt Transducer and Current Transducer Specifications

	Continuum NetController with UI-8-10	Continuum NetController with MI-6	SCX 920	LCX 800/800I	LCX 810	Eclipse 9400 with UI-xx-yy*
Output Type from Watt Transducer	Analog, 4-20 mA (preferred) or voltage type					
Accuracy from Watt Transducer	$\pm 0.5\%$ (not including CT's)					
Maximum Wire Length (ft.)	500 ft. @ 18 AWG wire					
CT Accuracy	$\pm 1.0\%$					
Note	CT sensors <ul style="list-style-type: none"> • Output: Match the input type for Watt Transducer • Input: Make sure that input current is enough to cover the normal current 					
End-to-end Accuracy for Current Input	N/A	$\pm (1.5\% \text{ reading plus } 0.5\% \text{ range})$	$\pm (1.5\% \text{ reading plus } 0.2\% \text{ range})$	$\pm (1.5\% \text{ reading plus } 0.5\% \text{ range})$	$\pm (1.5\% \text{ reading plus } 0.2\% \text{ range})$	$\pm (1.5\% \text{ reading plus } 0.2\% \text{ range})$
End-to-end Accuracy for Voltage Input	$\pm (1.5\% \text{ reading plus } 0.3\% \text{ range})$	N/A	$\pm (1.5\% \text{ reading plus } 0.05\% \text{ range})$	$\pm (1.5\% \text{ reading plus } 0.3\% \text{ range})$	$\pm (1.5\% \text{ reading plus } 0.03\% \text{ range})$	$\pm (1.5\% \text{ reading plus } 0.05\% \text{ range})$

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

Next, the specifications for the Watt Transducer must satisfy the input requirements for the controller. Make sure that the device will cover the peak demand kW. An example of the available Watt Transducer is shown in the next chart. The Current Transducer is already included in this example.

Chart B-3. Electrical Consumption Monitoring Using Watt Transducer

Example Watt Transducer Specifications

Watt Transducer (CT included)		
Veris Industries, Inc.		
H-8040		
Input	Primary Voltage	208 or 480 VAC rms
	Phase	One-Phase or Three-Phase
	Primary Current	Up to 2400 amps cont. per phase
Output	Type	4 – 20 mA
	Supply Power	9 – 30 V dc; 30 mA max
	Accuracy	$\pm 1\%$
	Internal Isolation	2000 VAC rms
	Case Insulation	600 VAC rms
	Current Transformer	Split core, 100, 300, 400, 800, 1600 or 2400 amps

Chart B-4. Electrical Consumption Monitoring Using Watt Transducer

EMCS Programming Steps

Summary

1. Set-up external analog input point in EMCS to store demand from Watt transducer.
2. Set-up internal analog point to accumulate monthly consumption from external point created in Step 1.
3. Create Trend point extension on internal analog output point in EMCS to record 15-minute accumulated consumption values.
4. Add a programming step to accumulate the point value created in Step 1 and store in the point created in Step 2.

Details of these steps follow.

Step 1. Set-up external analog input point in EMCS to store demand from Watt transducer.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

- a. Connect installed sensors to the controller.
- b. From “Menu” page, click “Tool”, then “Continuum Explorer”.
- c. Right click on the controller to which the point will be added.
- d. Select “New” from the menu, and then select “InfinityInput”.
- e. New dialog box will be displayed. Enter the name and alias and click “Create”.
- f. InfinityInput Editor will be displayed. Set the following parameters as specified below:
 - In “General” Tab,

Value	0 (This value will be shown when this point is not active)
Unit	kW
Description	Enter a point description up to 32 characters in length
State	Enabled

Continued on Next Page

- In “Setting” Tab,

	Continuum NetController with UI-8-10	Continuum NetController with MI-6	SCX 920	LCX 800/800I	LCX 810	Eclipse 9400 with UI-xx-yy*
ElecType	Voltage	InputCurrent	InputCurrent for current sensor or Voltage for current/voltage sensor			
Channel	x, x is the terminal connection IN-x. For example, a sensor is installed at IN-5, the channel is 5.					
IOU	Number of the Input/Output module that is sending the input	0	0	0	0	Number of the Input/Output board on Lbus
Format	###.## (floating point)					
Digital Filter	False					

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

- In “Conversions” Tab

Threshold	0.00 (The point will be updated with every change)
Auto Conversion	<p>Top kW: the kW value corresponding to the high signal from sensor</p> <p>Top Current: 20 mA</p> <p>Bottom kW: the kW value corresponding to the low signal from sensor</p> <p>Bottom Current: 4 mA</p> <p>For instance, Watt Transducer is set-up to send out signal 0 kW demand at 4 mA and 500 kW demand at 20 mA. The bottom value in this case is 0 and the top value is 500.</p>
	<ul style="list-style-type: none"> • Click “OK”

Step 2. Set-up internal analog point to accumulate monthly consumption from external point created in Step 1.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

- a. In Continuum Explorer window, right click on the controller to which the point will be added.
- b. Select “New” from the menu, and then select “InfinityNumeric”.
- c. New dialog box will be displayed. Enter the name and alias and click “Create”.
- d. InfinityNumeric Editor will be displayed. Set the following parameters as specified below:
 - In “General” Tab,

Value	0 (This is the initial value)
Unit	kWh
Description	Enter a point description up to 32 characters in length
Channel and IOU number	(NetControllers only) Enter the channel number as it is marked on the controller. Enter an IOU number.
Direction	IOOutput
State	Enabled
Setpoint	No Check
Format	###.## (2 decimal floating points)

Step 3. Create trend point extension on internal analog output point in EMCS to record 15-minute accumulated consumption values.

Continue from Step 2. “InfinityNumeric Editor” window will be displayed. Set the following parameters as specified below:

- In “Logs” Tab, on the left side of the Logs page

Number of Entries	3,500 (3,500 points will be kept at the controller)
Type	LogInstantaneous
Interval	Days: 0 Hours: 0 Minutes: 15 Seconds: 0 (Andover automatic logs always start at the top of the hour, so the data will be recorded every quarter of the hour)

- In “Logs” Tab, on the right side of the Logs page

Number of Entries	17,520 (the maximum amount of numbers that the Continuum database will keep)
Interval	Days: 0 Hours: 4 Minutes: 0 Seconds: 0 (Continuum will store new values in the log every four hours)
	Note: To maintain a good data history, a monthly export of data is needed.

Step 4. Add a programming step to accumulate the point value created in Step 1 and store in the point created in Step 2.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

- a. In Plain English Integrated Development Environment, click “New” from the IDE File menu. The Create dialog box will display a list of objects.
- b. In Network View, under Device section, select the controller in which this program will be stored.
- c. Enter the name of this program, up to 16 characters, in the field marked “Object Name”.
- d. Click “Create”, then configure program file attributes.
- e. Select “Configuration” from the File menu and fill in the configuration page dialog box.
- f. Click “Enabled” state, “Looping” flow type, and check the boxes on “Autostart” and “Command Line”.
- g. Select run time page and then click “OK”.
- h. New program editor window will be displayed. Enter the program lines to accumulate the electrical consumption from electrical demand (See Appendix A).
- i. When complete and before saving a file, make sure the Assistant window is displayed.
- j. From File Menu select “Save”. The IDE automatically checks the file for errors before saving. If errors are found, the Check tab on the Assistant window becomes active and lists the errors. The IDE will not save a program file and will not close until all the errors are fixed.

Application C. Thermal Consumption Monitoring Using a BTU Meter

Charts C-1 through C-4 provide the user with steps to follow in setting up a BTU meter to monitor thermal consumption. By following these steps, the user will enable the EMCS to measure thermal consumption (MMBTU) and store fifteen-minute data. Chart C-1 lists the needed equipment and will help the user determine if the controller has an available input slot. Chart C-2 aids the user in choosing a BTU meter, temperature sensors and a flow meter. The chart lists the BTU meter, temperature sensor, and flow meter accuracy for the different controller models. The chart also lists output type, pulse widths and pulse rates the BTU meter must have. Some tips for BTU meter selection and flow meter installation are provided as well. Chart C-3 provides an example of a BTU meter, a temperature sensor and a flow meter available in the market. Chart C-4 provides the EMCS programming steps. By following these steps, the user will enable the EMCS to accumulate monthly thermal consumption and record 15-minute thermal consumption. The user should then proceed to Application F to set-up the data collection and history data storage.

Step 1. Check the input slot availability on the controller.

Use Chart C-1 to find which slots are needed on the controller. The position of the slot can be found in Chart C-1 under Controller Terminal Connections. For example, SCX 920 needs an available slot on IN 1-16. If slots are available on either of these the procedure can be followed. If there are no available slots, contact an Andover Controls representative to check whether an expansion I/O module can be added to this controller or if an additional controller needs to be installed.

Step 2. Choose a BTU Meter, Temperature Sensor and Flow Meter.

Chart C-2 lists the BTU meter, temperature sensor and flow meter specifications. For example, an acceptable BTU meter for SCX 920 should have discrete output with at least 100 ms pulse width at 5 Hz maximum pulse rate. This BTU meter should be installed with matching temperature sensors and flow meter output at the recommended accuracy. The end-to-end accuracy of this thermal measurement does not depend only on the meter

and sensors but also the characteristics of the system (differential temperature). Chart C-2 and Appendix B provide more information about this.

Chart C-3 shows examples of a BTU meter, temperature sensors and a flow meter provided in the market.

Step 3. Follow the EMCS programming steps.

Chart C-4 provides the steps to set-up the external input point (from the BTU Meter) the EMCS will need to recognize. Detailed steps provided in this chart must be followed to set-up the external input point and internal points.

Step 4. Follow the steps in Application F.

Application F lists the steps to set-up the data collection and history data storage.

After these steps are complete, the system will be usable to collect and store monthly thermal consumption data.

Chart C-1. Thermal Consumption Monitoring Using a BTU Meter

Verify that in addition to the sensors and transducer, that the controller has the available slots as discussed below. Also, the terminal connections on the controller need to have the resistors connected as specified below.

	Continuum NetController with UI-8-10	Continuum NetController with DI-8	SCX 920	LCX 800/800I	LCX 810	Eclipse 9400 with UI-xx-yy* or DI-32-DRY
What is measured	<ul style="list-style-type: none"> Chilled/Hot water flow Chilled/Hot water supply and return temperature 					
What is stored in EMCS	<ul style="list-style-type: none"> Fifteen-minute data of Thermal Consumption in MMBtu units stored in Trend Data History 					
What is needed	1 – Flow meter 2 – Temperature sensors 1 – BTU meter 1 – available slot on Terminal Block (for digital input)					
Controller Terminal Connections	IN 1-8	High Speed Counter: IN 1-2 Low Speed Counter: IN 1-8	IN 1-16	IN 1-8	IN 1-8	IN 1-16 for 16 inputs and IN 1-32 for 32 inputs
DIP Switch Position	Ref. Resistor: ON Voltage Range: 5V (Optional)	For IN 1-2 High Speed Counting, High Speed Counter: ON	Ref. Resistor: IN	N/A	Ref. Resistor: IN	Current Sense Resistor: OFF or Pull-up Resistor: ON

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

Chart C-2. Thermal Consumption Monitoring Using a BTU Meter

BTU Meter, Flow Meter and Temperature Sensor Specifications

	Continuum NetController with UI-8-10	Continuum NetController with DI-8	SCX 920	LCX 800/800I	LCX 810	Eclipse 9400 with UI-xx-yy* or DI-32-DRY
Output Type from BTU Meter	Digital Pulse (each pulse is equal to xxx MMBTU, varies with specific meter)					
Maximum Pulse Rate	4 Hz	High Speed Counting: 10 kHz and Low Speed Counting: 10 Hz	5 Hz	4 Hz	4 Hz	5 Hz
Minimum Pulse Width	125 ms	High Speed Counting: 50 μ s and Low Speed Counting: 50 ms	100 ms	125 ms	125 ms	100 ms
Accuracy from Flow Meter	Recommended Accuracy for flow meter is \pm 1% full scale					
Accuracy from Temperature Sensor	Recommended Accuracy: \pm 0.2 °F for chilled water temperature sensors and \pm 0.5 °F for hot water temperature sensors.					
End-to-end Accuracy	Depends on the accuracy of the temperature sensor, flow meter and how large the temperature difference is. Assuming the difference between chilled water supply and return temperature is 10 °F, the end-to-end accuracy can approach 5%. Assuming the difference between hot water supply and return temperature is 20 °F, the accuracy can approach 7%, without end-to-end calibration. See Appendix B					

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

Tips on BTU Meter selection:

- Make sure that the BTU meter will cover the peak BTU, will not generate pulses more than the maximum pulse rate and will maintain the output pulse signal with at least the minimum pulse width duration.
- Use matched temperature sensors.
- Temperature sensor and flow meter outputs are correct for the BTU meter inputs.
- The specifications for the BTU Meters must satisfy the input requirements for the controller.

Notes on installation:

- Install the flow meter in either the supply or return pipe.
- Install matched temperature sensors, one on the supply pipe and another sensor on the return pipe.
- For the temperature sensor on the same pipe as the flow meter, install the sensor close to the flow meter.
- Disconnect the flow meter and temperature sensors at the BTU meter input board. Follow the manufacturer's instructions.
- Disconnect the BTU meter output at the terminal block. Follow the manufacturer's instructions.

Chart C-3. Thermal Consumption Monitoring Using a BTU Meter

Example BTU Meter, Flow Meter and Temperature Sensor Specifications

The following BTU meter, flow meter and temperature sensors have been successfully used.

BTU Measurement System		
Keegan Electronics, Inc.		
System 90 Series		
Input	Temperature	2 matched temperature sensors supplied by Keegan Electronics
	Minimum Resolution of Temperature reading	0.1°C
	Flow	1 flow sensor supplied by Data Industrial
	Minimum Closure Duration	2 milliseconds
	Maximum Length of cable	500 feet
	Electrical	Connect to high voltage (120 V AC) through a circuit breaker
Output	Standard Output	Monostable relay outputs, SPST, 2A @ 120 V AC resistive representing BTU's and Gallons
	Optional Output	0-1 mA DC or 4-20 mA DC representing instantaneous BTU/Hr and GPM
	Accuracy	Depends on the accuracy of temperature sensor, flow meter and how large the temperature difference is.

Chart C-3. Thermal Consumption Monitoring Using a BTU Meter (continued)**Example BTU Meter, Flow Meter and Temperature Sensor Specifications**

Temperature Sensor		
Keegan Electronics, Inc.		
RTD for System 90 Series		
Input	Temperature Range	0-100 °C
Output	Standard Output	RTD – variable resistance
	Reference	@ 0°C – output is equal to 32,654 ohms @ 100°C – output is equal to 679 ohms
	Accuracy	± 0.2 °C

Flow Sensor		
Data Industrial		
220 PVCS Insert Flow Sensor		
Input	Flow Rate	1 to 30 ft./sec
	Maximum Pressure	100 psi @ 68°F
	Maximum Temperature	140°F @ 40 psi
	Maximum Length of cable	20 feet shielded twisted pair AWG 20
Output	Standard Output	Voltage pulse, 5V or greater
	Accuracy	± 1% of Full Scale (over recommended design flow range)
	Absolute Accuracy	± 4% of reading within calibration range
	Linearity	± 1%
	Frequency	3.2 – 200 Hz
	Pulse Width	5 milliseconds ± 25%

Chart C-4. Thermal Consumption Monitoring Using a BTU Meter

EMCS Programming Steps

Summary

1. Set-up an external pulse input point in EMCS to accumulate daily consumption for the BTU Meter.
2. Set-up an internal output point to accumulate monthly consumption from the external point created in Step 1.
3. Create a trend point extension on the internal output point in the EMCS to record the 15-minute accumulated consumption values.
4. Add a programming step to accumulate the counter value created in Step 1 and store in the point created in Step 2.

Details of these steps follow.

Step 1. Set-up an external pulse input point in EMCS to accumulate daily consumption for the BTU Meter.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

- a. Connect installed sensors to the controller .
- b. From “Menu” page, click “Tool”, then “Continuum Explorer”.
- c. Right click on the controller to which the point will be added.
- d. Select “New” from the menu, and then select “InfinityInput”.
- e. New dialog box will be displayed. Enter the name and alias and click “Create”.
- f. InfinityInput Editor will be displayed. Set the following parameters as specified below:
 - In “General” Tab,

Value	0 (This value will be shown when this point is not active)
Unit	MMBtu
Description	Enter a point description up to 32 characters in length
State	Enabled

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In “Setting” Tab,

	Continuum NetController with UI-8-10	Continuum NetController with DI-8	SCX 920	LCX 800/800I	LCX 810	Eclipse 9400 with UI-xx-yy* or DI-32-DRY
ElecType	Counter					
Channel	x, x is the terminal connection IN-x. For example, a sensor is installed at IN-5, the channel is 5.					
IOU	Number of the Input/Output module that is sending the input	0	0	0	Number of the Input/Output board on Lbus	
Format	###.## (floating point)					
Digital Filter	False					

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

- In “Conversions” Tab

Threshold	0.00 (The point will be updated with every change)
-----------	--

Step 2. Set-up internal output point to accumulate monthly consumption from the external point created in Step 1.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

- a. In Continuum Explorer window, right click on the controller to which the point will be added.
- b. Select “New” from the menu, and then select “InfinityNumeric”.
- c. New dialog box will be displayed. Enter the name and alias and click “Create”.
- d. InfinityNumeric Editor will be displayed. Set the following parameters as specified below:
 - In “General” Tab,

Value	0 (This is the initial value)
Unit	MMBTU
Description	Enter a point description up to 32 characters in length
Channel and IOU number	(NetControllers only) Enter the channel number as it is marked on the controller. Enter an IOU number.
Direction	IOOutput
State	Enabled
Setpoint	No Check
Format	###.## (2 decimal floating points)

Step 3. Create a trend point extension on the internal output point in the EMCS to record the 15-minute accumulated consumption values.

Continue from Step 2. “InfinityNumeric Editor” window will be displayed. Set the following parameters as specified below:

- In “Logs” Tab, on the left side of the Logs page

Number of Entries	3,500 (3,500 points will be kept at the controller)
Type	LogInstantaneous
Interval	Days: 0 Hours: 0 Minutes: 15 Seconds: 0 (Andover automatic logs always start at the top of the hour, so the data will be recorded every quarter of the hour)

- In “Logs” Tab, on the right side of the Logs page

Number of Entries	17,520 (the maximum amount of numbers that the Continuum database will keep)
Interval	Days: 0 Hours: 4 Minutes: 0 Seconds: 0 (Continuum will store new values in the log every four hours)
	Note: To maintain a good data history, a monthly export of data is needed.

Step 4. Add a programming step to accumulate the counter value created in Step 1 and store in the point created in Step 2.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

- a. In Plain English Integrated Development Environment, click “New” from the IDE File menu. The Create dialog box will display a list of objects.
- b. In Network View, under Device section, select the controller in which this program will be stored.
- c. Enter the name of this program, up to 16 characters, in the field marked “Object Name”.
- d. Click “Create”, then configure program file attributes.
- e. Select “Configuration” from the File menu and fill in the configuration page dialog box.
- f. Click “Enabled” state, “Looping” flow type, and check the boxes on “Autostart” and “Command Line”.
- g. Select run time page and then click “OK”.
- h. New program editor window will be displayed. Enter the program lines to accumulate the thermal consumption (See Appendix A).
- i. When complete and before saving a file, make sure the Assistant window is displayed.
- j. From File Menu select “Save”. The IDE automatically checks the file for errors before saving. If errors are found, the Check tab on the Assistant window becomes active and lists the errors. The IDE will not save a program file and will not close until all the errors are fixed.

Application D. Thermal Consumption Monitoring Using an EMCS

Charts D-1 through D-4 provide the user with steps to follow in setting up an EMCS to monitor thermal consumption. By following these steps, the user will enable the EMCS to measure thermal consumption (MMBTU) and store fifteen-minute data. Chart D-1 lists the needed equipment and will help the user determine if the controller has an available input slot. Chart D-2 aids the user in choosing temperature sensors and a flow meter. The chart lists the temperature sensor and flow meter accuracy and output type. Some tips for temperature sensor and flow meter installation are provided as well. Chart D-3 provides an example of a temperature sensor and a flow meter available in the market. Chart D-4 provides the EMCS programming steps. By following these steps, the user will enable the EMCS to accumulate monthly thermal consumption and record 15-minute thermal consumption. The user should then proceed to Application F to set-up the data collection and history data storage.

Step 1. Check the input slot availability on the controller.

Use Chart D-1 to find which slots are needed on the controller. The position of the slot can be found in Chart D-1 under Controller Terminal Connections. For example, LCX 810 needs an available slot on IN 1-8. If slots are available on either of these the procedure can be followed. If there are no available slots, contact an Andover Controls representative to check whether an expansion I/O module can be added to this controller or if an additional controller needs to be installed.

Step 2. Choose a Temperature Sensor and Flow Meter.

Chart D-2 lists the temperature sensor and flow meter specifications. For example, an acceptable temperature sensor and flow meter for LCX 810 should have analog output, either current or voltage output. The end-to-end accuracy of this thermal measurement does not depend only on the meter and sensors but also the characteristics of the system (differential temperature). Chart D-2 and Appendix B provide more information on this.

Chart D-3 shows an example of temperature sensors and flow meter provided in the market.

Step 3. Follow the EMCS programming steps.

Chart D-4 provides the steps to set-up the external input point (from the temperature sensor and flow meter) and internal points used to store the consumption that the EMCS will need to recognize. Detailed steps provided in this chart must be followed to set-up the external input point and internal points.

Step 4. Follow the steps in Application F.

Application F lists the steps to set-up the data collection and history data storage.

After these steps are complete, the system will be usable to collect and store monthly thermal consumption data.

Chart D-1. Thermal Consumption Monitoring Using an EMCS

Verify that in addition to the sensors and transducer, that the controller has the available slots as discussed below. Also, the terminal connections on the controller need to have the resistors connected as specified below.

	Continuum NetController with UI-8-10	Continuum NetController with MI-6	SCX 920	LCX 800/800I	LCX 810	Eclipse 9400 with UI-xx-yy*
What is measured	<ul style="list-style-type: none"> Chilled/Hot water flow Chilled/Hot water supply and return temperature 					
What is stored in EMCS	<ul style="list-style-type: none"> Fifteen-minute data of Thermal Consumption in MMBTU units stored in Trend Data History 					
What is needed	1 – Flow meter 2 – Temperature sensors 3 – available slots on Terminal Block (for analog input from flow meter and temperature sensors) 2 – available internal points <ul style="list-style-type: none"> 1 – available internal analog output point (to calculate for instantaneous thermal consumption) 1 – available internal pulse input point (to accumulate month-to-date consumption) 					
Controller Terminal Connections**	IN 1-8 (voltage)	IN 1-6 (current)	IN 1-16	IN 1-8	IN 1-8	IN 1-16 for 16 inputs and IN 1-32 for 32 inputs
DIP Switch Position	Ref. Resistor: OFF Voltage Range: 5V for 0-5V Input Range or 10V for 0-10V Input Range (Optional)	N/A	Ref. Resistor: OUT For Current Input: recommended additional resistor across the input, 475 Ω for a 0-20 mA input	For Current Input: recommended additional resistor across the input, 249 Ω for a 0-20 mA input.	Ref. Resistor: OUT For Current Input: recommended additional resistor across the input, 475 Ω for a 0-20 mA input.	Pull-up Resistor: OFF Current Sense Resistor: OFF for voltage input, ON for current input (Optional)

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

** Controller Terminal Connections for analog inputs, both current and voltage inputs, otherwise stated.

Chart D-2. Thermal Consumption Monitoring Using an EMCS

Flow Meter and Temperature Sensor Specifications

	Continuum NetController with UI-8-10	Continuum NetController with MI-6	SCX 920	LCX 800/800I	LCX 810	Eclipse 9400 with UI-xx-yy*
Output Type from Flow Meter	Analog, either voltage or current (preferred) output					
Output Type from Temperature Sensors	Analog, current output					
Maximum Wire Length (ft.)	500 ft. @ 18 AWG wire					
End-to-end Accuracy	End-to-end accuracy depends on the accuracy of temperature sensor, flow meter and how large the temperature difference is. Assuming the difference between chilled water supply and return temperature is 10 °F, the end-to-end accuracy can approach 5%. Assuming the difference between hot water supply and return temperature is 20 °F, the accuracy can approach 7%, without end-to-end calibration. See Appendix B					
Note	<ul style="list-style-type: none"> • Recommended accuracy for temperature sensor: ± 0.2 °F of full scale for chilled water temperature sensors and ± 0.5 °F of full scale for hot water temperature sensor • Recommended accuracy for flow meter: $\pm 1\%$ of full scale • Temperature sensors should be matched 					

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

Notes on installation:

- Install the flow meter in either the supply or return pipe.
- Install matched temperature sensors, one on the supply pipe and another on the return pipe.
- For the temperature sensor on the same pipe as the flow meter, install the sensor close to the flow meter.
- Disconnect the flow meter and temperature sensors at the Terminal Blocks. Follow the manufacturer's instructions.

Chart D-3. Thermal Consumption Monitoring Using an EMCS**An Example of Flow Meter and Temperature Sensor Specifications**

The following Flow Meter and Temperature sensors have been successfully used.

Temperature Sensor		
Minco Products, Inc		
RTD with TempTran transmitter		
Input	Temperature Range	30-80 °F (for chilled water system)
Output	Standard Output	Current, 4-20 mA
	Accuracy	± 0.2 % of span

Flow Meter and Transmitter		
Rosemount		
8705 with the integral mounted type transmitter model 8732		
Input	Flow Rate	0.04 to 30 ft./sec
	Maximum Pressure	285 psi @ 100°F
	Temperature Condition	Natural Rubber Lining: 0 to 185 °F
	Minimum Liquid Conductivity	5 microsiemens/cm
Output	Standard Output	Current, 4-20 mA
	Accuracy	± 0.5% of rate from 1 to 30 ft/sec and from ± 0.005 ft/sec to 0.04 ft/sec

Chart D-4. Thermal Consumption Monitoring Using an EMCS

EMCS Programming Steps

Summary

1. Set-up external analog input points in the EMCS for the flow meter and temperature sensors.
2. Set-up two internal analog points in the EMCS for instantaneous and month-to-date thermal consumption.
3. Create a trend point extension on the internal output point in the EMCS to record the 15-minute accumulated consumption values.
4. Add a programming step to calculate the instantaneous and monthly thermal consumption.

Details of these steps follow.

Step 1. Set-up external analog input points in the EMCS for the flow meter and temperature sensors.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

- a. Connect installed sensors to the controller.
- b. From “Menu” page, click “Tool”, then “Continuum Explorer”.
- c. Right click on the controller to which the point will be added.
- d. Select “New” from the menu, then select “InfinityInput”.
- e. New dialog box will be displayed. Enter the name and alias and click “Create”.
- f. InfinityInput Editor will be displayed. Set the following parameters as specified below:

- In “General” Tab,

Value	0 (This value will be shown when this point is not active)
Unit	gpm
Description	Enter a point description up to 32 characters in length
State	Enabled

- In “Setting” Tab,

	Continuum NetController with UI-8-10	Continuum NetController with MI-6	SCX 920	LCX 800/800I	LCX 810	Eclipse 9400 with UI-xx-yy*
ElecType	Voltage	InputCurrent	InputCurrent for current sensor or Voltage for current/voltage sensor			
Channel	x, x is the terminal connection IN-x. For example, a sensor is installed at IN-5, the channel is 5.					
IOU	Number of the Input/Output module that is sending the input		0	0	0	Number of the Input/Output board on Lbus
Format	###.## (floating point)					
Digital Filter	False					

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

- In “Conversions” Tab

Threshold	0.00 (The point will be updated with every change)
Auto Conversion	<p>Top GPM : the GPM value corresponding to the high signal from sensor</p> <p>Top Current: 20 mA</p> <p>Bottom GPM: the GPM value corresponding to the low signal from sensor</p> <p>Bottom Current: 4 mA</p> <p>For instance, when the flow meter is set-up to send out signal 0 GPM at 4 mA and 900 GPM at 20 mA, the bottom value in this case is 0 and the top value is 900.</p>
	<ul style="list-style-type: none"> • Click “OK”

Repeat the above step to set-up analog input points for flow meter and temperature sensors.

Step 2. Set-up two internal analog points in the EMCS for instantaneous and month-to-date thermal consumption.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

- a. In Continuum Explorer window, right click on the controller to which the point will be added.
- b. Select “New” from the menu, then select “InfinityNumeric”.
- c. New dialog box will be displayed. Enter the name and alias and click “Create”.
- d. InfinityNumeric Editor will be displayed. Set the following parameters as specified below:
 - In “General” Tab,

Value	0 (This is the initial value)
Unit	MMBTU/hr
Description	Enter a point description up to 32 characters in length
Channel and IOU number	(NetControllers only) Enter the channel number as it is marked on the controller. Enter an IOU number.
Direction	IOOutput
State	Enabled
Setpoint	No Check
Format	###.## (floating point)

Repeat the above step to set-up analog point for month-to-date thermal consumption.

Step 3. Create a trend point extension on the internal output point in the EMCS to record the 15-minute accumulated consumption values.

Continue from Step 2. “InfinityNumeric Editor” window will be displayed. Set the following parameters as specified below:

- In “Logs” Tab, on the left side of the Logs page

Number of Entries	3,500 (3,500 points will be kept at the controller)
Type	LogInstantaneous
Interval	Days: 0 Hours: 0 Minutes: 15 Seconds: 0 (Andover automatic logs always start at the top of the hour, so the data will be recorded every quarter of the hour)

- In “Logs” Tab, on the right side of the Logs page

Number of Entries	17,520 (the maximum amount of numbers that Continuum database will keep)
Interval	Days: 0 Hours: 4 Minutes: 0 Seconds: 0 (Continuum will store new values in the log every four hours)
	Note: To maintain a good data history, a monthly export of data is needed

Step 4. Add a programming step to calculate the instantaneous and monthly thermal consumption.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

- a. In Plain English Integrated Development Environment, click “New” from the IDE File menu. The Create dialog box will display a list of objects.
- b. In Network View, under Device section, select the controller in which this program will be stored.
- c. Enter the name of this program, up to 16 characters, in the field marked “Object Name”.
- d. Click “Create”, then configure program file attributes.
- e. Select “Configuration” from the File menu and fill in the configuration page dialog box.
- f. Click “Enabled” state, “Looping” flow type, and check the boxes on “Autostart” and “Command Line”.
- g. Select run time page and then click “OK”.
- h. New program editor window will be displayed. Enter the program lines to accumulate the thermal consumption from the calculated instantaneous thermal consumption (See Appendix C).
- i. When complete and before saving a file, make sure the Assistant window is displayed.
- j. From File Menu select “Save”. The IDE automatically checks the file for errors before saving. If errors are found, the Check tab on the Assistant window becomes active and lists the errors. The IDE will not save a program file and will not close until all the errors are fixed.

Application E. Room Temperature Monitoring.

Charts E-1 through E-4 guide the user through steps to follow in setting up a temperature sensor to monitor room temperature. Following these steps will enable the EMCS to measure room temperature (°F) and store fifteen-minute data. Chart E-1 lists the needed equipment and will help the user determine if the controller has an available input slot. Chart E-2 aids the user in choosing a temperature sensor. The chart lists each type of output from sensor accuracy for different controller models. In addition, the chart lists wire and sensor specifications. Chart E-3 provides an example of a temperature sensor available in the market. Chart E-4 provides the EMCS programming steps. By following these steps the user will enable the EMCS to display current temperature and record 15-minute temperature. The user should then proceed to Application F to set-up the data collection and history data storage.

Step 1. Check the input slot availability on the controller.

Use Chart E-1 to find which slots are needed on the controller. The position of the slot can be found in Chart E-1 under Controller Terminal Connections. There are three types of temperature sensor inputs, which are acceptable in most controllers: current, voltage and thermistor. Any of these inputs can be chosen depending on the application. For example, Eclipse 9400 needs an available slot on IN1-16 for 16 inputs module for a thermistor temperature sensor. If there are no available slots please contact an Andover Controls representative to check whether an expansion I/O module can be added to this controller or if an additional controller needs to be installed.

Step 2. Choose a Temperature Sensor.

Chart E-2 lists the temperature sensor specifications. For example, an acceptable temperature sensor for Eclipse 9400 should have analog output with $\pm 1^{\circ}\text{F}$ accuracy or better. The end-to-end accuracy from the temperature sensor to the Eclipse 9400 controller could be under $\pm 1.5^{\circ}\text{F}$. Note that to gain this accuracy the temperature sensor must be placed no further than 500 ft. away with 18 AWG type wire. If this accuracy is not acceptable, a temperature with better accuracy is needed or the controller needs to be replaced.

Chart E-3 shows an example of a temperature sensor provided in the market.

Step 3. Follow the EMCS programming steps.

Chart E-4 provides the steps to set-up the external input point (from the sensor) the EMCS will need to recognize. Detailed steps provided in this chart must be followed to set-up the external input point.

Step 4. Follow the steps in Application F.

Application F lists the steps to set-up the data collection and history data storage.

After these steps are complete, the system will be usable to display the current temperature and record 15-minute temperature data.

Chart E-1. Room Temperature Monitoring

Verify that in addition to the sensors and transducer, that the controller has the available slots as discussed below. Also, the terminal connections on the controller need to have the resistors connected as specified below.

	Continuum NetController with UI-8-10	Continuum NetController with MI-6	SCX 920	LCX 800/800I	LCX 810	Eclipse 9400 with UI-xx-yy*
What is measured	<ul style="list-style-type: none"> Room Temperature 					
What is stored in EMCS	<ul style="list-style-type: none"> Fifteen-minute data of room temperature in °F unit stored in Trend Data History 					
Needed	1 – Temperature sensor 1 – Available slot on Terminal Block (depends on output type of each device)					
Controller Terminal Connections**	IN 1-8 (thermistor,voltage)	IN 1-6 (current)	IN 1-16	IN 1-8	IN 1-8	IN 1-16 for 16 inputs and IN 1-32 for 32 inputs
DIP Switch Position	For Thermistor, Ref. Resistor: ON Voltage Range: 5V For Voltage, Ref. Resistor: OFF and Voltage Range: 5V for 0-5V Input Range or 10V for 0-10V Input Range (Optional)	N/A	For Thermistor, Ref. Resistor: IN. For current and voltage, Ref. Resistor: OUT For Current Input: recommended additional resistor across the input, 475 Ω for a 0-20 mA input	For Current Input: recommended additional resistor across the input, 249 Ω for a 0-20 mA input.	For Thermistor, Ref. Resistor: IN. For current and voltage, Ref. Resistor: OUT For Current Input: recommended additional resistor across the input, 475 Ω for a 0-20 mA input	Pull-up Resistor: ON for thermistor, OFF for current and voltage Current Sense Resistor: OFF for thermistor and voltage input, ON for current input (Optional)

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

** Controller Terminal Connections for analog inputs, current, voltage and thermistor inputs, otherwise stated.

Chart E-2. Room Temperature Monitoring

Temperature Sensor Specifications

	Continuum NetController with UI-8-10	Continuum NetController with MI-6	SCX 920	LCX 800/800I	LCX 810	Eclipse 9400 with UI-xx-yy*
Output Type from Temperature Sensors	Analog, current, voltage or thermistor output					
Accuracy from Temperature sensor	Recommended accuracy for room temperature sensor ± 1.0 °F. This accuracy can be lower depending on the application used					
End-to-end Accuracy for current output**	N/A	± 1.5 °F	± 1.2 °F	± 1.5 °F	± 1.2 °F	± 1.2 °F
End-to-end Accuracy for voltage output**	± 1.3 °F	N/A	± 1.1 °F	± 1.3 °F	± 1.1 °F	± 1.1 °F
End-to-end Accuracy for thermistor output**	± 2.0 °F	N/A	± 1.5 °F	± 2.5 °F	± 1.5 °F	± 1.3 °F
Maximum Wire Length (ft.)	500 ft. @ 18 AWG wire					

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

** temperature sensor with current, voltage or thermistor output range from 0 to 100 °F

Chart E-3. Room Temperature Monitoring

Example Temperature Sensor Specification

Temperature Sensor		
Vaisala		
HMD 60 Y, Duct Temperature Transmitter		
Input	Temperature Range	-20 to 80 °C
Output	Standard Output	Current, 4-20 mA
	Accuracy	± 0.6 °C over the span
	Linearity	0.1 °C or better

Chart E-4. Room Temperature Monitoring

EMCS Programming Steps

Summary

1. Set-up an external analog input point in the EMCS
2. Create Trend point extension on external analog input point in EMCS to record 15-minute temperature values.

Details of these steps follow.

Step 1. Set-up an external analog input point in the EMCS.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

- a. Connect installed sensors to the controller.
- b. From “Menu” page, click “Tool”, then “Continuum Explorer”.
- c. Right click on the controller to which the point will be added.
- d. Select “New” from the menu, then select “InfinityInput”.
- e. New dialog box will be displayed. Enter the name and alias and click “Create”.
- f. InfinityInput Editor will be displayed. Set the following parameters as specified below:
 - In “General” Tab,

Value	0 (This value will be shown when this point is not active)
Unit	DegF
Description	Enter a point description up to 32 characters in length
State	Enabled

- In “Setting” Tab,

	Continuum NetController with UI-8-10	Continuum NetController with MI-6	SCX 920	LCX 800/800I	LCX 810	Eclipse 9400 with UI-xx-yy*
ElecType	Voltage or AccTemp(degF) for Thermistor	InputCurrent	InputCurrent for current sensor, Voltage for current/voltage sensor or AccTemp(degF) for thermistor			
Channel	x, x is the terminal connection IN-x. For example, a sensor is installed at IN-5, the channel is 5.					
IOU	Number of the Input/Output module that is sending the input	0	0	0	0	Number of the Input/Output board on Lbus
Format	####.## (2 floating points)					
Digital Filter	False					

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

- In “Conversions” Tab

Threshold	0.00 (The point will be updated with every change)
Auto Conversion	<p>Top DegF : the temperature value corresponding to the high signal from sensor</p> <p>Top Current: 20 mA</p> <p>Bottom DegF: the temperature value corresponding to the low signal from sensor</p> <p>Bottom Current: 4 mA</p> <p>For instance, when the temperature sensor is set-up to send out signal 30°F at 4 mA and 90°F at 20 mA, the bottom value in this case is 30 and the top value is 90.</p>
	<ul style="list-style-type: none"> • Click “OK”

Step 2. Create Trend point extension on external analog input point in EMCS to record 15-minute temperature values.

Continue from Step 1. “InfinityNumeric Editor” window will be displayed. Set the following parameters as specified below:

- In “Logs” Tab, on the left side of the Logs page

Number of Entries	3,500 (3,500 points will be kept at the controller)
Type	LogInstantaneous
Interval	Days: 0 Hours: 0 Minutes: 15 Seconds: 0 (Andover automatic logs always start at the top of the hour, so the data will be recorded every quarter of the hour)

- In “Logs” Tab, on the right side of the Logs page

Number of Entries	17,520 (the maximum amount of numbers that Continuum database will keep)
Interval	Days: 0 Hours: 4 Minutes: 0 Seconds: 0 (Continuum will store new values in the log every four hours)
	Note: To maintain a good data history, a monthly export of data is needed

Application F. Data Collection Configuration and Storage In Continuum CyberStation Workstation Software

To maintain the data after the extended log limit is reached, a program can be written to read from the extended log and write to a text file.

In ContinuumTM CyberStationTM Workstation Software, perform the following steps:

- a. In Plain English Integrated Development Environment, click “New” from the IDE File menu. The Create dialog box will display a list of objects.
- b. In Network View, under Device section, select the controller in which this program will be stored.
- c. Enter the name of this program, up to 16 characters, in the field marked “Object Name”.
- d. Click “Create”, then configure program file attributes.
- e. Select “Configuration” from the File menu and fill in the configuration page dialog box.
- f. Click “Enabled” state, “Looping” flow type, and check the boxes on “Autostart” and “Command Line”.
- g. Select run time page and then click “OK”.
- h. New program editor window will be displayed. Enter the program lines to retrieve all extended log entries (See Appendix D).
- i. When complete and before saving a file, make sure the Assistant window is displayed.
- j. From File Menu select “Save”, the IDE automatically checks the file for errors before saving. If errors are found, the Check tab on the Assistant window becomes active and lists the errors. The IDE will not save a program file and will not close until all the errors are fixed.

This manual archive is recommended to be performed monthly to maintain data history.

Andover will also provide a logging archiver module, which will be completed in the near future. This archiving option is called “Continuum Reports – Extended Log Archiver” and will provide Automatic Archiver, Manual Archiver and Archived Data Reporter features. Automatic Archiver will provide unattended time scheduled archiving of Extended Log data to externally maintained

database files and unattended Extended Log Database table truncation. Manual Archiver will provide the same feature as Automatic Archiver but has to be initiated manually. Archived Data Reporter will retrieve, preview or print the archived data by date range, group and point selection. It can also extract the archived data into Continuum graphing, or CSV file creation for 3rd party application graphing.

APPENDICES

Appendix A: Electrical Consumption Accumulation Program

Appendix B: Thermal Consumption Accuracy

Appendix C: Thermal Consumption Calculation Program

Appendix D: Extended Log Archiving Program

Appendix A: Electrical Consumption Accumulation Program

Electrical demand in the unit of kW is obtained and can be accumulated by this program for electrical consumption. The following formula is used to determine an electrical energy usage.

Scan.cur is the length in seconds of the last interpreter scan to the CURrent SCAN.

Bldg1.kw is the measured electrical demand in kW.

Kw.cur is the CURrent scan electrical demand in kW.

Kw.prev is the PREVIOUS scan electrical demand in kW.

Tot.kwh is the calculated TOTAl electrical consumption in kWh.

Scan.prev is the length in seconds of the last interpreter scan and the PREVIOUS SCAN.

Monthly.kwh is the calculated electrical consumption in kWh at the end of each MONTH.

Flag1 is the local variable to determine the new month.

```

NUMERIC MONTHLY.KWH, TOT.KWH, SCAN.CUR, KW.CUR, SCAN.PREV, KW.PREV, FLAG1
SET TOT.KW, KW.PREV, FLAG1 = 0
LINE KWACCUMULATION
    SCAN.CUR = SCAN
    KW.CUR = BLDG1.KW
    TOT.KWH = TOT.KWH + (KW.PREV+KW.CUR)*SCAN.CUR/7200
    KW.PREV = KW.CUR
    SCAN.PREV = SCAN.CUR
    IF (DAYOFMONTH = 28, 30 OR 31) AND TOD = 2359 THEN
        IF MONTH = 2 AND FLAG1 = 0 THEN GOTO RESET
        IF DAYOFMONTH = 30 AND TOD = 2359 THEN
            IF (MONTH = 4, 6, 9 OR 11) AND FLAG1 = 0 THEN GOTO RESET
        ELSE
            IF DAYOFMONTH = 31 AND TOD = 2359 THEN
                IF (MONTH = 1, 3, 5, 7, 8, 10 OR 12) AND FLAG1 = 0 THEN GOTO RESET
            ENDIF
        ENDIF
    ENDIF
    IF (DAYOFMONTH = 1) AND FLAG1 = 1 THEN
        SET FLAG1 = 0
    ENDIF
    GOTO KWACCUMULATION

LINE RESET
    MONTHLY.KWH = TOT.KWH
    SET FLAG1 = 1
    SET TOT.KWH = 0

```


Appendix B: Thermal Consumption Accuracy

The accuracy of thermal consumption depends on the temperature sensor accuracy, the flow meter accuracy, and the temperature difference as shown in the following tables. Each table represents the thermal consumption calculation accuracy based on a specific temperature difference and combinations of temperature sensor accuracy and flow meter accuracy. For example, if a chilled water system has a temperature difference between the supply and return at 8°F and we would like to control the thermal consumption accuracy to be below 10%, we can select several combinations of temperature sensors and flow meters from the accuracy shown in Table B.2. We can choose a temperature sensor at either 0.2 or 0.5°F accuracy with a flow meter of 0.5, 1 or 2% accuracy. For instance, a combination of temperature sensors with 0.5 °F accuracy, a flow meter with 2% accuracy and an 8°F temperature difference, yield a thermal consumption calculation accuracy of 8.38%. A better accuracy can be achieved with a more accurate temperature sensor, a more accurate flow meter or a higher difference in temperature. The thermal consumption accuracy of the above example can be improved from 8.38% to 4.55% using a temperature sensor with 0.2°F accuracy. Note that the above accuracy does not include the accuracy from the controller reading, signal loss along the wire, etc. The accuracy takes into account the temperature sensor and flow meter only.

Table B.1 Thermal Consumption Calculation Accuracy Based on 5°F Temperature Difference

Flow meter accuracy (%)	Temperature sensor accuracy (°F)			
	0.2	0.5	1.0	2.0
0.5	4.52 %	10.55 %	20.60 %	40.70 %
1	5.04 %	11.10 %	21.20 %	41.40 %
2	6.08 %	12.20 %	22.40 %	42.80 %

Table B.2 Thermal Consumption Calculation Accuracy Based on 8 °F Temperature Difference

Flow meter accuracy (%)	Temperature sensor accuracy (°F)			
	0.2	0.5	1.0	2.0
0.5	3.01 %	6.78 %	13.06 %	25.63 %
1	3.53 %	7.31 %	13.63 %	26.25 %
2	4.55 %	8.38 %	14.75 %	27.5 %

Table B.3 Thermal Consumption Calculation Accuracy Based on 10 °F Temperature Difference

Flow meter accuracy (%)	Temperature sensor accuracy (°F)			
	0.2	0.5	1.0	2.0
0.5	2.51 %	5.53 %	10.55 %	20.60 %
1	3.02 %	6.05 %	11.10 %	21.20 %
2	4.04 %	7.10 %	12.20 %	22.40 %

Table B.4 Thermal Consumption Calculation Accuracy Based on 12 °F Temperature Difference

Flow meter accuracy (%)	Temperature sensor accuracy (°F)			
	0.2	0.5	1.0	2.0
0.5	2.18 %	4.69 %	8.88 %	17.25 %
1	2.68 %	5.21 %	9.42 %	17.83 %
2	3.70 %	6.25 %	10.50 %	19.00 %

Appendix C: Thermal Consumption Calculation Program

Supply and return water temperature and their flow rates are obtained for thermal consumption calculation. The following formula is used to determine a thermal energy usage, applicable to both chilled water and hot water system.

Scan.time.cur is the length in seconds of the last interpreter scan to the CURrent SCAN.

Bldg1.temp.chws is the measured CHilled Water Supply TEMPerature in °F.

Bldg1.temp.chwr is the measured CHilled Water Return TEMPerature in °F.

Temp.ret.cur is the CURrent chilled water RETurn TEMPerature in °F.

Temp.sup.cur is the CURrent chilled water SUPply TEMPerature in °F.

Bldg1.flow.chw is the measured CHilled Water FLOW rate in gpm.

Flow.cur is the CURrent chilled water FLOW rate in gpm.

Temp.diff is the calculated chilled water DIFFerential TEMPerature.

Temp.degc is the calculated chilled water return TEMPerature in °C.

Temp.P2 is chilled water return TEMPerature in °C Power of 2.

Temp.P3 is chilled water return TEMPerature in °C Power of 3.

Temp.P4 is chilled water return TEMPerature in °C Power of 4.

Temp.P5 is chilled water return TEMPerature in °C Power of 5.

Chw.density is the calculated CHilled Water DENSITY.

Mmbtuh.cur is the CURrent calculated instantaneous chilled water consumption in MMBTU/hr.

Mmbtuh.prev is the PREVIOUS calculated instantaneous chilled water consumption in MMBTU/hr

Tot.mmbtu is the calculated TOTAl chilled water consumption in MMBTU.

Scan.time.prev is the length in seconds of the last interpreter scan and the PREVIOUS SCAN.

Monthly.mmbtu is the calculated thermal consumption in MMBTU at the end of each MONTH.

Flag2 is the local variable to determine the new month.

```

NUMERIC MONTHLY.MMBTU, TOT.MMBTU, SCAN.TIME.CUR, MMBTUH.CUR, SCAN.TIME.PREV, MMBTUH.PREV, FLAG2
NUMBERIC TEMP.SUP.CUR, TEMP.RET.CUR, FLOW.CUR, TEMP.DIFF, TEMP.DEGC, TEMP.P2, TEMP.P3, TEMP.P4, TEMP.P5, CHW.DENSITY
SET TOT.MMBTU, MMBTUH.PREV, FLAG2 = 0
LINE MMBTUCALCANDACCUM
    SCAN.TIME.CUR = SCAN
    TEMP.SUP.CUR = BLDG1.TEMP.CHWS
    TEMP.RET.CUR = BLDG1.TEMP.CHWR
    FLOW.CUR = BLDG1.FLOW.CHW
    TEMP.DIFF = TEMP.RET.CUR - TEMP.SUP.CUR
    TEMP.DEGC = (TEMP.RET.CUR - 32)*5/9
    TEMP.P2 = TEMP.DEGC * TEMP.DEGC
    TEMP.P3 = TEMP.P2 * TEMP.DEGC
    TEMP.P4 = TEMP.P3 * TEMP.DEGC
    TEMP.P5 = TEMP.P4 * TEMP.DEGC
    CHW.DENSITY = (999.8395 + 0.06798*TEMP.DEGC - 0.00911*TEMP.P2 + 0.0001*TEMP.P3 - 1.127E-06*TEMP.P4 +
        6.592E-09*TEMP.P5)/16.01846
    MMBTUH.CUR = FLOW.CUR * TEMP.DIFF * CHW.DENSITY * 1.0005 * 60 / 7.4805 / 1000 / 1000
    TOT.MMBTU = TOT.MMBTU + (MMBTUH.PREV+MMBTUH.CUR)*SCAN.TIME.CUR/7200
    MMBTUH.PREV = MMBTUH.CUR
    SCAN.TIME.PREV = SCAN.TIME.CUR
    IF (DAYOFMONTH = 28, 30 OR 31) AND TOD = 2359 THEN
        IF MONTH = 2 AND FLAG2 = 0 THEN GOTO THERMALRESET
        IF DAYOFMONTH = 30 AND TOD = 2359 THEN
            IF (MONTH = 4, 6, 9 OR 11) AND FLAG2 = 0 THEN GOTO THERMALRESET
        ELSE
            IF DAYOFMONTH = 31 AND TOD = 2359 THEN
                IF (MONTH = 1, 3, 5, 7, 8, 10 OR 12) AND FLAG2 = 0 THEN GOTO THERMALRESET
            ENDIF
        ENDIF
    ENDIF
    IF (DAYOFMONTH = 1) AND FLAG2 = 1 THEN
        SET FLAG2 = 0
    ENDIF
    GOTO MMBTUCALCANDACCUM

LINE THERMALRESET
    MONTHLY.MMBTU = TOT.MMBTU
    SET FLAG2 = 1
    SET TOT.MMBTU = 0

```

Appendix D: Extended Log Archiving Program

To retrieve all extended log entries for a point called TEMP1 on a controller called FLOOR1 and place them in a data file called Temp1Data, the following program can be used. The resulting data file would contain the time and value of each log entry.

```
Numeric OpenResult, GetLogResult, CloseResult
Numeric LogEntryValue
DateTime LogTime
Object TempPoint

OpeningLog
    OpenResult = OpenList("ExtendedLog", TempPoint, Floor1 Temp1)

Initializing
    If OpenResult is Success Then
        LogTime = Date - 30*24*3600
    Else
        Print "Could not open extended log"
    Endif

RetrievingEntry
    GetLogResult = GetExtLog(TempPoint, LogEntryValue, LogTime, Date)

TestingRetrieval
    If GetLogResult = Success Then
        Print LogTime, LogEntryValue to Temp1Data
        Goto RetrievingEntry
    Endif

ClosingLog
    CloseResult = CloseList(TempPoint)

TestingClose
    If CloseResult is not success Then
        Print "Could not close extended log"
    Endif
```